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True bugs (Hemiptera, Heteroptera) as psyllid predators (Hemiptera, Psylloidea)

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Abstract

Data on natural enemies of psyllids are rare and can usually be found in papers about economically significant species. During an investigation of psyllid fauna in Serbia, natural enemies were investigated, too. True bugs were the most numerous among them. From 28 psyllid species, 21 species of true bugs from families Anthocoridae and Miridae were reared. Seven species of Anthocoridae were identified: *Anthocoris amplicollis* (Horváth, 1839), *A. confusus* Reuter, 1884, *A. nemoralis* (Fabricius, 1794), *A. nemorum* (Linnaeus, 1761), *Orius majusculus* Reuter, 1884, *O. minutus* (Linnaeus, 1758) and *O. niger* Wolff, 1811. The following 14 species of Miridae were identified: *Atractotomus mali* Meyer-Dür, 1843, *Campylomma verbasci* (Meyer-Dür, 1843), *Deraeocoris flavilinea* (A. Costa, 1862), *D. ruber* (Linnaeus, 1758), *D. lutescens* (Schilling, 1836), *Heterocordylus genistae* (Scopoli, 1763), *Hypseloecus visci* (Puton, 1888), *Malacocoris chlorizans* Panzer, 1794, *Miris striatus* (Linnaeus, 1758), *Orthotylus marginalis* Reuter, 1884, *Psallus assimilis* Stichel, 1956, *Ps. quercus* Kirschbaum, 1856, *Ps. flavellus* Stichel, 1933 and *Pseudoloxops coccinea* (Meyer-Dür, 1843). The aim of the research was to provide list of true bugs recorded as predators of psyllids in order to preserve their diversity and significance, especially on cultivated plants.

Keywords

Psylloidea, Heteroptera, predators, natural enemies, Serbia

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Introduction

Predators of psyllids (Psylloidea) have been poorly known. So far, detailed researches were carried out only on the predators of economically significant species, such as pear psyllids *Cacopsylla pyri* (Linnaeus, 1758), *C. pyricola* (Foerster, 1848) and *C. pyrisuga* (Foerster, 1848); apple psyllid *C. mali* (Schmidberger, 1836) and eucalyptus psyllids from the subfamily Spondyliaspidinae (Jonsson 1983, Herard 1985, 1986, Santas 1987, Erler 2004, Horton et al. 2004, Sigsgaard et al. 2006, Jauset et al. 2006, Luiz de Queiroz et al. 2012). There are too few data on predators of other psyllid species. Hodkinson and Flint (1971) investigated predators of ash psyllid, *Psyllopsis fraxini* (Linnaeus, 1758), in England, and Harizanova et al. (2012), predatory complex of *Acizzia jamatonica* (Kuwayama, 1908) in Bulgaria. In these papers, the most represented are psyllid predators from the order Hemiptera (suborder Heteroptera) followed by Coleoptera, Neuroptera, Diptera, Dermaptera and Acari. Within the Heteroptera, the most numerous in species families are Anthocoridae, Miridae and Nabidae. A polyphagous species, *Anthocoris nemoralis* (Fabricius, 1794), was most frequently found, with a preference for the species from superfamily Psylloidea (Jonsson 1983, Herard 1986). *Anthocoris nemoralis* (Anthocoridae) was introduced from Europe to North America (British Columbia) in 1963 in order to control *C. pyricola*, where its establishment was successful. Besides giving satisfactory effects, this species also spread in the new environment suppressing autochthonous species *Anthocoris antevolens* White, 1879 and *A. melanocerus* Reuter, 1884, which are most common anthocorid predators in orchards (Herard 1986, Horton et al. 2004).

Data on psyllid predators in Serbia relate only to the predators of pear psyllids (Pavićević 1977, Grbić et al. 1989, Jerinić-Prodanović et al. 2010).

Pavićević (1977) found a large number of predatory species, among which two were from family Anthocoridae. Grbić et al. (1989) recorded four species of Heteroptera: *Anthocoris nemoralis* and *Orius* sp. (both Anthocoridae), *Pilophorus clavatus* (Linnaeus, 1767) (Miridae) and *Nabis pseudoferus* Remane, 1949 (Nabidae), while Jerinić-Prodanović et al. (2010) reported seven species: *Anthocoris nemoralis* (Fabricius, 1794), *A. nemorum* (Linnaeus, 1761), *Orius* (*Heterorius*) *minutus* (Linnaeus, 1758) and *Orius* (*Orius*) *niger* Wolff, 1811 from the family Anthocoridae and *Campylomma verbasci* (Meyer-Dür, 1843), *Deraeocoris* (*Deraeocoris*) *ruber* (Linnaeus, 1758) and *Deraeocoris* (*Knightocapsus*) *lutescens* (Schilling, 1836) from the family Miridae.

There is no data on other predatory psyllid species in Serbia.

Methods

Insect material was collected from 419 localities within the whole territory of the Republic of Serbia. Investigations were carried out in the period from 2005 to 2010, in field conditions and in the laboratory of the Faculty of Agriculture in Zemun, University of Belgrade. Locality mapping was carried out in World UTM (Universal Trans-

verse Mercator) cartographic projection. Determination of coordinates of investigated localities in the field was carried out using GPS devices Geoexplorer 3 (Trimble) and E-trex Vista Hcx (Garmin), with an accuracy of 3 to 5 meters.

Adults of predatory true bugs were collected from psyllid colonies by an aspirator and their larvae were collected together with plant material and psyllids and further reared to adults in laboratory conditions in Petri dishes.

The species identification of Heteroptera was based on Wagner (1970–1971, 1975), Péricart (1972) and Kerzhner and Josifov (1999).

A part of the material is deposited in the first author's collection in the Faculty of Agriculture, University of Belgrade, and another part, in the second author's collection in Natural History Museum, Belgrade.

Results and discussion

We collected and reared 21 true bug species predating on 28 psyllid species (Table 1) from 44 localities (Fig. 1 and Table 2). The identified true bugs belong to families Anthocoridae and Miridae.

Anthocoridae

1) *Anthocoris amplicollis* (Horváth, 1839)

Trophic status. Zoophagous.

Distribution. Europe.

Prey. *Psylla buxi* (Linnaeus, 1758), from *Buxus sempervirens*, Nova Galenika, 13.VI.2009, reared 3♂♂, 2♀♀.

A. amplicollis was already reported in Serbia (Protić and Stojanović 2003) but the above mentioned record is the first one in Serbia as a psyllid predator. In Switzerland, it was registered by Wyniger and Burckhardt (2003) in galls of *Psyllopsis fraxini*. According to available literature data, *A. amplicollis* has not been published as a predator of *P. buxi*.

2) *Anthocoris confusus* Reuter, 1884

Trophic status. Zoophagous.

Distribution. Palaearctic.

Prey. *Psylla buxi*, from *Buxus semprevirens*, Sokobanja, 25.IX.2009, reared 1♀.

Registered as a psyllid predator on conifers (Wyniger and Burckhardt 2003) and aphids (Herard 1986). In the present paper, reported for the first time as a psyllid predator in Serbia.

Table 1. List of preys (Psylloidea) and their predators (Heteroptera) and host plants in Serbia.

Preys (Psylloidea)	Predators (Heteroptera)																				
	Anthocoridae							Miridae													
	Ant amp	**Ant con**	**Ant nea**	**Ant neu**	**Ori maj**	**Ori min**	**Ori nig**	**Atr mal**	**Cam ver**	**Der fla**	**Der lut**	**Der rub**	**Het gen**	**Hyp vis**	**Mal chl**	**Mir str**	**Ort mar**	**Psa ass**	**Psa fla**	**Psa que**	**Pse coc**
Baeopelma foersteri						Aln glu															
Cacopsylla affinis				Cra mon				Cra mon													
Cacopsylla bidens			Pyr com	Pyr com			Pyr com		Pyr com	Pyr com											
Cacopsylla melanoneura				Cra mon		Mal dom	Mal dom	Mal dom, Cra mon	Mal dom				Mal dom, Cra mon			Cra mon					
Cacopsylla peregrina				Cra mon				Cra mon								Cra mon					
Cacopsylla picta						Mal dom		Mal dom													
Cacopsylla pulchra				Sal pur																	
Cacopsylla pyri			Pyr com	Pyr com		Pyr com	Pyr com		Pyr com		Pyr com	Pyr com									
Cacopsylla pyricola									Pyr com												
Cacopsylla pyrisuga			Pyr com	Pyr com					Pyr com												
Cacopsylla rhamnicola						Rha cat					Rha cat						Rha cat				
Cacopsylla visci			Vis alb	Vis alb										Vis alb							

Preys (Psylloidea)	Predators (Heteroptera)																				
	Anthocoridae							Miridae													
	Ant amp	**Ant con**	**Ant nea**	**Ant neu**	**Ori maj**	**Ori min**	**Ori nig**	**Atr mal**	**Cam ver**	**Der fla**	**Der lut**	**Der rub**	**Het gen**	**Hyp vis**	**Mal chl**	**Mir str**	**Ort mar**	**Psa ass**	**Psa fla**	**Psa que**	**Pse coc**
Camarotoscena speciosa			Pop nig			Pop nig					Pop nig										
Craspedolepta sp.							Art vul														
Homotoma ficus						Fic car				Fic car					Fic car						
Livia junci							Jun bul														
Psylla buxi	Bux sem	Bux sem		Bux sem																	
Psyllopsis discrepans			Fra spp		Fra spp	Fra orn				Fra ang								Fra spp	Fra spp	Fra orn, Fra spp	
Psyllopsis fraxini			Fra spp																		
Psyllopsis fraxinicola			Fra spp	Fra ang		Fra spp	Fra orn				Fra ang							Fra spp			Fra spp
Psyllopsis machinosa			Fra spp		Fra spp	Fra orn				Fra ang										Fra spp	
Psyllopsis meliphila			Fra spp																		
Psyllopsis repens			Fra spp			Fra orn															
Trichochermes walkeri							Rha cat														
Trioza chenopodii							Atr tat				Atr obl										

Preys (Psylloidea)	Predators (Heteroptera)																				
	Anthocoridae							Miridae													
	Ant amp	**Ant con**	**Ant nea**	**Ant neu**	**Ori maj**	**Ori min**	**Ori nig**	**Atr mal**	**Cam ver**	**Der fla**	**Der lut**	**Der rub**	**Het gen**	**Hyp vis**	**Mal chl**	**Mir str**	**Ort mar**	**Psa ass**	**Psa fla**	**Psa que**	**Pse coc**
Trioza mesembrina						Cha hir															
Trioza rhamni						Rha cat				Rha cat											
Trioza urticae			Urt dio				Urt dio														

Abbreviations

Predators. **Anthocoridae**: Ant amp, *Anthocoris amplicollis*; Ant con, *Anthocoris confusus*; Ant nea, *Anthocoris nemoralis*; Ant neu, *Anthocoris nemorum*; Ori maj, *Orius majusculus*; Ori min, *Orius minutus*; Ori nig, *Orius niger*; **Miridae**: Atr mal, *Atractotomus mali*; Cam ver, *Campylomma verbasci*; Der fla, *Deraeocoris flavilinea*; Der lut, *Deraeocoris lutescens*; Der rub, *Deraeocoris ruber*; Het gen, *Heterocordylus genistae*; Hyp vis, *Hypseloecus visci*; Mal chl, *Malacocoris chlorizans*; Mir str, *Miris striatus*; Ort mar, *Orthotylus marginalis*; Psa ass, *Psallus assimilis*; Psa fla, *Psallus flavellus*; Psa que, *Psallus quercus*; Pse coc, *Pseudoloxops coccinea*.

Host plants: Aln glu, *Alnus glutinosa*; Art vul, *Artemisia vulgaris*; Atr obl, *Atriplex oblongifolia*; Atr tat, *Atriplex tatarica*; Bux sem, *Buxus sempervirens*; Cha hir, *Chaerophyllum hirsutum*; Cra mon, *Crataegus monogyna*; Fic car, *Ficus carica*; Fra ang, *Fraxinus angustifolia*; Fra orn, *Fraxinus ornus*; Fra spp, *Fraxinus* spp.; Jun bul, *Juncus bulbosus*; Mal dom, *Malus domestica*; Pop nig, *Populus nigra*; Pyr com, *Pyrus communis*; Rha cat, *Rhamnus cathartica*; Sal pur, *Salix purpurea*; Vis alb, *Viscum album*; Urt dio, *Urtica dioica*.

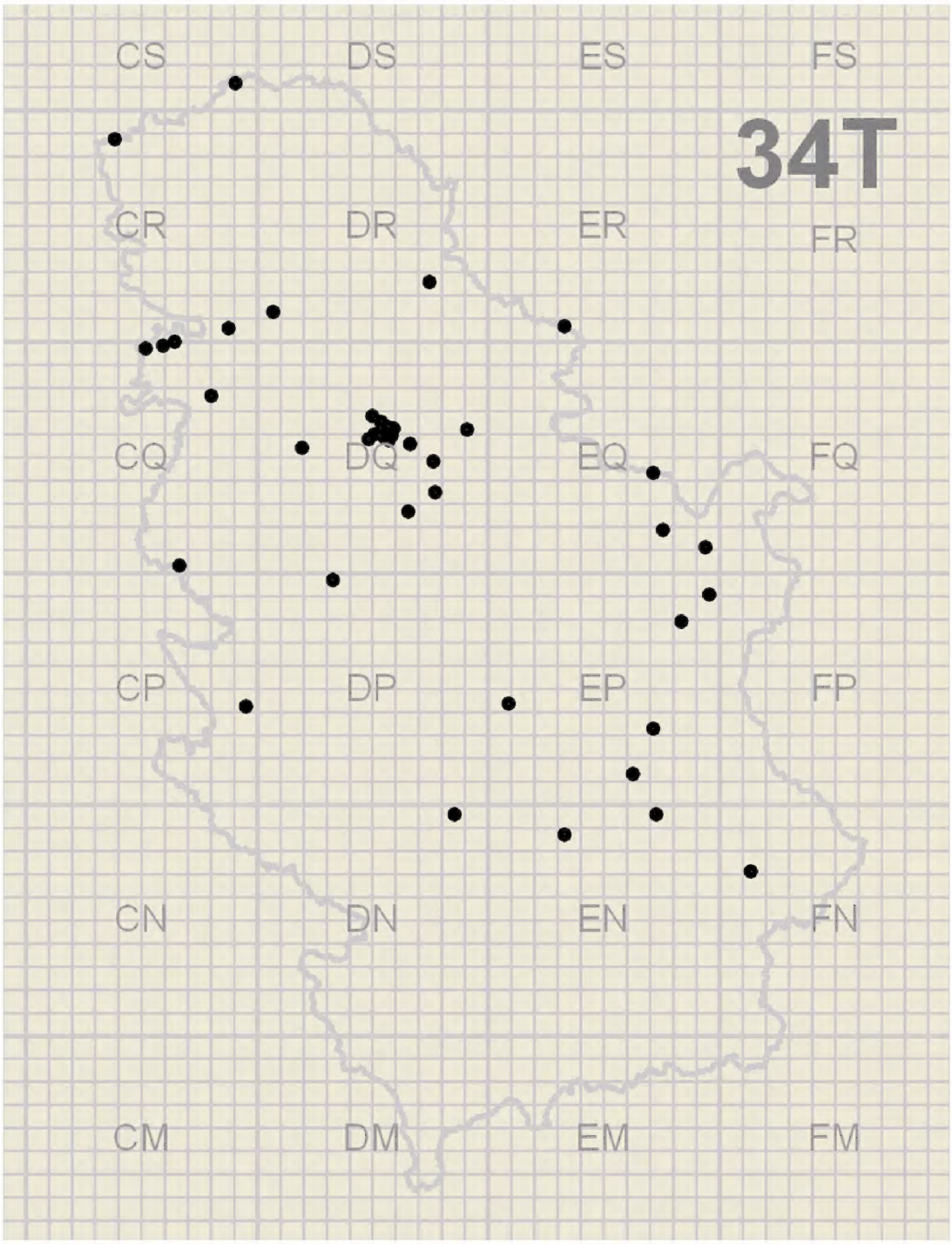

Figure 1. Localities in Serbia where true bug predators of psyllids were collected.

3) *Anthocoris nemoralis* (Fabricius, 1794)

Trophic status. Zoophagous.

Distribution. Euro-Mediterranean.

Preys. ***Cacopsylla bidens* (Šulc, 1907)**, from *Pyrus communis*, Beograd–Karaburma, 19.V.2006, reared 2♀♀ 'ex larva'25.V.2006. ***Cacopsylla pyri***, from *Pyrus communis*, Nemenikuće, 15.VI.2006, reared 1♂ 'ex larva'22.VI.2006; Radmilovac, 2.IX.2005, reared 1♂; 12.VI.2006, reared 1♂ 'ex larva'25.VI.2006; 26.X.2006, collected 1♂; 7.VI.2007, reared 1♂, 1♀ 'ex larva'11.VI.2007, 20.VI.2007, collected 1 larva and 1♂; 26.X.2008, reared 1♂ 'ex larva'3.XI.2008. ***Cacopsylla pyrisuga***, from *Pyrus communis*, Zemunski kej, 28.V.2007, collected 1♀. ***Cacopsylla visci* (Curtis, 1835)**, from *Viscum album*, Beograd–Bulevar Aleksandra Karađorđevića, 25.III.2007, reared 2♂♂, 1♀ 'ex larva'12.IV.2007; 23.IV.2007, reared 2♂♂, 5♀♀

'ex larva'3.V.2007. ***Camarotoscena speciosa*** **(Flor, 1861)**, from *Populus nigra*, Radmilovac, 22.V.2000, reared 1♂ 'ex larva'25.V.2000; Zemun–Nova Galenika, 25.VIII.2008, collected 1♀; 1.IX.2008, reared 3♀♀ 'ex larva'9.IX.2008; 10.IX.2008, collected 1♀, 1♂; 17.IX.2008, collected 1♀, 1♂; 24.IX.2008, reared 2♂♂, 2♀♀ 'ex larva'1.X.2008; 27.VII.2010, collected 1♂, 1♀, 18.X.2010, collected 1♂, 1♀. ***Psyllopsis discrepans*** **(Flor, 1861)**, from *Fraxinus* sp., Beograd–Autokomanda, 10.V.2007, reared 1♀; Brestovačka Banja, 25.V.2007, reared 5♂♂, 4♀♀ 'ex larva'8. VI.2007; Ilinci, 24.V.2008, collected 1♂; Majdanpek, 25.V.2007, reared 1♂, 1♀ 'ex larva'3.VI.2007, Milošev konak, 21.VI.2007, 1♂. ***Psyllopsis fraxini***, from *Fraxinus* sp., Veliko Središte, 30.V.2006, reared 2♀♀. ***Psyllopsis fraxinicola*** **(Foerster, 1848)**, from *Fraxinus* sp., Beograd–Autokomanda, 10.V.2007, reared 1♀; Beograd–Kalemegdan, 24.V.2007, collected 1♂; Brestovačka Banja, 25.V.2007, reared 5♂♂, 4♀♀ 'ex larva'8.VI.2007; Majdanpek, 25.V.2007, reared 1♂, 1♀ 'ex larva'3.VI.2007; Veliko Središte, 4.VI.2006, reared 2♀♀ 'ex larva'19.VI.2006. ***Psyllopsis machinosa*** **Loginova, 1963**, from *Fraxinus* sp., Beograd–Autokomanda, 10.V. 2007, reared 1♀. ***Psyllopsis meliphila*** **Löw, 1881**, from *Fraxinus* sp., Nemenikuće, 15.VI.2006, collected 1♂. ***Psyllopsis repens*** **Loginova, 1963**, from *Fraxinus* sp., Beograd–Autokomanda, 14.X.2008, reared 1♀. ***Trioza urticae*** **(Linnaeus, 1758)**, from *Urtica dioica*, Ilinci, 24.VI.2007, collected 2♀♀ .

A. nemoralis is an important component of the natural enemy community in pear and apple orchards where it provides biological control against arthropod pests, particularly psyllids (Horton et al. 2004). Investigating the predator–prey complex of *C. pyri* in a pear orchard in France, Herard (1986) found that *A. nemoralis* was the most efficient enemy against this pest. *A. nemoralis* is mentioned in many papers as a permanent member of biocomplexes of pear psyllids in Europe (Wheeler 2000b, Erler 2004, Sigsgaard et al. 2006). In Turkey, *A. nemoralis* was an equally present and efficient predator of pear psyllid *C. pyri*, both in treated and untreated orchards, but still insufficient for its full control (Erler 2004). In Spain, Jauset et al. (2006) determined *A. nemoralis* as a very efficient predator of *C. pyri*, both in treated and untreated pear orchards. Now, there is a mass production of *A. nemoralis* in companies specialized for biological control of harmful insects (Sigsgaard et al. 2006). The same authors reported that *A. nemoralis* mostly prefers *C. pyri* to aphids, and that it prefers laying eggs on pear to apple. *A. nemoralis* is a polyphagous predatory species having psyllids as a usual prey.

It is distributed in Europe and the Mediterranean. From Europe it was introduced into North America in 1963 in order to control pear psyllid *C. pyricola*, giving satisfactory results (Horton et al. 2004). This species has adapted to this region so well that it has suppressed autochthonous predatory species *A. antevolens* and *A. melanocerus* (Herard 1986, Horton et al. 2004). In Serbia, in a pear orchard, Pavićević (1977), Grbić et al. (1989) and Jerinić-Prodanović (2010) note a permanent presence of *A. nemoralis*, both during vegetation and winter period together with an overwintering adult of *C. pyri*. *A. nemoralis* was also reported as a predator of *Psyllopsis repens* in Serbia (Malenovský and Jerinić-Prodanović 2011).

Table 2. Geographical coordinates of inspected localities.

No	Locality	Latitude	Longitude	Altitude
1	Bački breg	45°55'21"N	18°55'24"E	90
2	Bavanište	44°48'42"N	20°53'10"E	80
3	Beloljin	43°14'03"N	21°24'26"E	290
4	Beograd–Autokomanda	44°47'20"N	20°28'20"E	100
5	Beograd–Banjica	44°45'18"N	20°28'58"E	190
6	Beograd–Block 45	44°47'36"N	20°22'47"E	75
7	Beograd–Bulevar Aleksandra Karadjordjevića	44°46'50"N	20°27'31"E	175
8	Beograd–Hotel Jugoslavija	44°49'36"N	20°25'22"E	75
9	Beograd–Hram Svetog Save	44°47'53"N	20°28'03"E	120
10	Beograd–Kalemegdan	44°49'19"N	20°26'52"E	110
11	Beograd–Karaburma	44°48'48"N	20°29'15"E	110
12	Beograd–Milošev konak	44°46'38"N	20°25'36"E	80
13	Beograd–Voždovac	44°47'17"N	20°28'28"E	85
14	Brestovačka Banja	44°03'36"N	22°02'36"E	360
15	Dobra	44°38'23"N	21°54'06"E	85
16	Draževac	43°28'08"N	21°46'37"E	205
17	Galovica	44°46'22"N	20°21'04"E	75
18	Grocka	44°41'21"N	20°42'02"E	125
19	Ilinci	45°06'41"N	19°07'16"E	80
20	Izvor	43°04'58"N	22°23'57"E	290
21	Kelebija	46°08'59"N	19°35'10"E	125
22	Kopaonik–Srebrenac	43°19'02"N	20°50'08"E	1740
23	Klokočevac	44°20'53"N	22°10'45"E	140
24	Koruška	45°11'46"N	19°34'23"E	110
25	Lipovača	45°08'24"N	19°16'53"E	165
26	Luka	44°09'46"N	22°11'56"E	340
27	Majdanpek	44°25'10"N	21°57'10"E	520
28	Nemenikuće	44°29'38"N	20°34'00"E	280
29	Niš	43°18'35"N	21°53'50"E	200
30	Novi Sad–Detelinara	45°15'50"N	19°48'56"E	80
31	Obedska bara	44°44'10"N	19°59'15"E	80
32	Oparić	43°44'40"N	21°06'38"E	310
33	Radenković	44°56'01"N	19°29'05"E	80
34	Radmilovac	44°45'15"N	20°34'39"E	160
35	Sokobanja	43°38'41"N	21°53'11"E	350
36	Sutjeska	45°23'02"N	20°41'53"E	75
37	Šid	45°07'31"N	19°12'58"E	105
38	Umčari	44°34'10"N	20°43'00"E	160
39	Uzovnica	44°16'12"N	19°19'47"E	170
40	Veliko Središte	45°12'54"N	21°25'30"E	120
41	Vrujci	44°13'26"N	20°09'53"E	170
42	Zemun–Nova Galenika	44°51'41"N	20°22'11"E	90
43	Zemunski kej	44°50'29"N	20°25'06"E	75
44	Zlatibor–Kraljevske Vode	43°43'39"N	19°42'06"E	950

4) *Anthocoris nemorum* (Linnaeus, 1761)

Trophic status. Zoophagous.

Distribution. Eurosiberian.

Preys. ***Cacopsylla affinis*** **(Löw, 1880)**, from *Crataegus monogyna*, Ilinci, 27.IV.2008, reared 1♂ 'ex larva'14.V. 2008. ***Cacopsylla bidens***, from *Pyrus communis*, Nemenikuće, 15.VI.2006, reared 1♀. ***Cacopsylla melanoneura*** **(Foerster, 1848)**, from *Crataegus monogyna*, Ilinci, 27.IV.2008, reared 1♂ 'ex larva'14.V.2008; Klokočevac, 10.V.2008, collected 1♀. ***Cacopsylla peregrina*** **(Foerster, 1848)**, from *Crataegus monogyna*, Ilinci, 27.IV.2008, reared 1♂ 'ex larva'14.V.2008. ***Cacopsylla pulchra*** **(Zetterstedt, 1838)**, from *Salix purpurea*, Zlatibor–Kraljevske Vode, 30.IV.2007, collected 1♀ and 1 larva. ***Cacopsylla pyri***, from *Pyrus communis*, Novi Sad–Detelinara, 23.V.2008, reared 2♂♂, 3♀♀ 'ex larva'4.VI.2008; 14.VI.2008, reared 3♂♂ 'ex larva'17.VI.2008. ***Cacopsylla pyrisuga***, from *Pyrus communis*, Grocka, 10.V.2008, reared 1♀ 'ex larva'23.V.2008. ***Cacopsylla visci***, from *Viscum album*, Beograd–Bulevar Aleksandra Karađorđevića, 23.IV.2007, reared 1♂ 'ex larva'3.V.2007. ***Psylla buxi***, from *Buxus sempervirens*, Vrujci, 1.VI.2009, collected 2♂♂, 1♀; Šid, 3.V.2008, collected 2♀♀; Zemun–Nova Galenika, 4.V.2008, reared 2♂♂, 3♀♀ 'ex larva'15.V.2008; 30.VII.2008, collected 1♀; 14.VI.2009, collected 2 specimens. ***Psyllopsis fraxinicola***, from *Fraxinus angustifolia*, Beograd–Hram Svetog Save, 14.IV.2008, reared 1♂ and 1 larva.

A. nemorum is noted as a predator of many insect species, in the first place Hemiptera, Diptera, eggs of Lepidoptera and mites (Herard 1986, Wheeler 2000b, Sigsgaard et al. 2006), already registered as a predator of both *C. pyri* and *Ps. fraxini* (Herard 1986). It is also largely reported as an efficient predator of apple psyllid *Cacopsylla mali* in Norway (Jonsson 1983). In England, Hodkinson and Flint (1971) determined *A. nemorum* as a predator of *Psyllopsis fraxini* collected from ash, while in Germany Novak and Achtziger (1995) registered it as a predator of hawthorn psyllids *Cacopsylla melanoneura* and *C. peregrina*. Sigsgaard et al. (2006) note *A. nemorum* as a more polyphagous species than *A. nemoralis*. They also determined in experimental conditions that *A. nemorum* prefers aphids to psyllids, and has a preference for laying eggs on apple rather than on pear.

A. nemorum is an Eurosiberian species, introduced to North America in order to control *C. pyricola* just like *A. nemoralis*, but without satisfactory results (Herard 1986).

A. nemorum is reported here for the first time as a predator of psyllids in Serbia.

5) *Orius* (*Heterorius*) *majusculus* Reuter, 1884

Trophic status. Zoophagous.

Distribution. Euro-Atlantic.

Preys. ***Psyllopsis discrepans*** and ***Psyllopsis machinosa***, from *Fraxinus* spp., Beograd–Autokomanda, 6.V.2009, collected 1♂.

O. majusculus was registered as a predator of psyllids (Herard 1986). It is noted as a predator of aphids, such as *Diuraphis noxia* and *Schizaphis graminum* in Russia, mites in France, whiteflies in greenhouses in Italy and pear psyllid *Cacopsylla pyri* in France (Péricart 1972, Herard 1986).

The present paper reports *O. majusculus* as a psyllid predator for the first time in Serbia and *Psyllopsis discrepans* and *Ps. machinosa* for the first time as a prey of *O. majusculus*.

6) *Orius* (*Heterorius*) *minutus* (Linnaeus, 1758)
Fig. 2

Trophic status. Zoophagous.

Distribution. Palaearctic.

Preys. ***Baeopelma foersteri* (Flor, 1861)**, from *Alnus glutinosa*, Radenković, 3.VI.2006, collected 1♀. ***Cacopsylla melanoneura***, from *Malus domestica*, Beograd–Hotel Jugoslavija, 26.V.2005, reared 1♂; Ilinci, 2.V.2010, reared 1♂, 2♀♀ 'ex larva'10.V.2010. ***Cacopsylla picta* (Foerster, 1848)**, from *Malus domestica*, Beograd–Hotel Jugoslavija, 26.V.2005, reared 1♂. ***Cacopsylla pyri***, from *Pyrus communis*, Radmilovac, 10.VII.2006, reared 1♂, 2♀♀ 'ex larva'20.VII.2006; 26.VII.2006, collected 1♂; 4.IX.2006, collected 1♂. ***Cacopsylla rhamnicola* (Scott, 1876)**, from *Rhamnus cathartica*, Kelebija, 25.V.2005, reared 1♀ 'ex larva'6.VI.2005. ***Camarotoscena speciosa***, from *Populus nigra*, Zemun–Nova Galenika, 1.IX.2008, reared 1♂ 'ex larva'9.IX.2008; 24.IX.2008, reared 1♂ 'ex larva'1.X.2008. ***Homotoma ficus* (Linnaeus, 1758)**, from *Ficus carica*, Beograd–Banjica, 23.IX.2008, collected 2♂♂, 3♀♀, feeding on eggs. ***Psyllopsis discrepans***, from *Fraxinus ornus*, Ilinci, 21.V.2005, collected 1♂. ***Psyllopsis discrepans*** and ***Psyllopsis repens***, from *Fraxinus ornus*, Beograd–Autokomanda, 7.IX.2008, reared 5♂♂, 4♀♀ 'ex larva'11.IX.2008; 21.IX.2008, collected 3♂♂; 23.IX.2008, collected 1♂; 7.X.2008, collected 1♂, 1♀; 14.X.2008, collected 1♀; 21.X.2008, collected 1♀. ***Psyllopsis fraxinicola***, from *Fraxinus* sp., Vrujci, 1.VII.2009, 1♀. ***Psyllopsis machinosa***, from *Fraxinus ornus*, Beograd–Autokomanda, 6.V.2009, reared 1♀ 'ex larva'10.V.2009. ***Psyllopsis repens***, from *Fraxinus ornus*, Beograd–Autokomanda, 21.VIII.2010, reared 1♀. ***Trioza mesembrina* Burckhardt, 1986**, from *Chaerophyllum hirsutum*, Kopaonik–Srebrenac, 7.VIII.2008, reared 1♂. ***Trioza rhamni* (Schrank, 1801)**, from *Rhamnus cathartica*, Kelebija, 25.V.2005, reared 1♀ 'ex larva'6.VI.2005; Ilinci, 2.V.2009, 1♂.

O. minutus is an extremely polyphagous species distributed in Europe, Siberia, China and Mediterranean region. Many authors determined it as a predator of harmful insect species from a number of orders (Thysanoptera, Diptera, Lepidoptera, Coleoptera and Hemiptera Homoptera). Already reported as a psyllid predator (Herard 1986). In France, Herard (1986) determined *O. minutus* as a predator of pear psyllids, primarily *C. pyri*, and hawthorn psyllids. Also in Slovenia, Vrabl and Matis (1977) register it as a predator of *C. pyri* and *C. pyrisuga*. In Serbia, Pavićević (1977) and Jerinić-Prodanović et al. (2010) determined *O. minutus* as a predator of *C. pyri* in

Figure 2. *Orius minutus* feeding on *Trioza rhamni*.

pear orchards. Malenovský and Jerinić-Prodanović (2011) also found it as a predator of *Ps. repens*. In Croatia, Arčanin and Balarin (1972) recognized the significance of *O. minutus* in the reduction of the mite *Panonychus ulmi*.

7) *Orius* (*Orius*) *niger* Wolff, 1811

Trophic status. Zoophagous.

Distribution. Palaearctic.

Preys. ***Cacopsylla bidens***, from *Pyrus communis*, Ilinci, 13.X.2008, collected 1♂. ***Cacopsylla melanoneura***, from *Malus domestica*, Lipovača, 29.IV.2006, collected 1♂. ***Cacopsylla pyri***, from *Pyrus communis*, Radmilovac, 26.VI.2006, reared 1♂ 'ex larva'30.VI.2006; 10.VII.2006, reared 1♀ 'ex larva'20.VII.2006. ***Craspedolepta* sp.**, from *Artemisia vulgaris*, Sutjeska, 2.X.2009, reared 1♂ and 4♀♀. ***Psyllopsis fraxinicola***, from *Fraxinus ornus*, Vrujci, 30.VI.2009, collected 1 specimen. ***Livia junci* (Schrank, 1789)**, from *Juncus bulbosus*, Beograd–Block 45, 10.VIII.2005, reared 1♂ 'ex larva'16.VIII.2005. ***Trichochermes walkeri* (Foerster, 1848)**, from *Rhamnus cathartica*, Ilinci, 14.IX.2008, 2♂♂, 2♀♀. ***Trioza chenopodii* Reuter, 1876**, from *Atriplex tatarica*, Ilinci, 20.VIII.2006, 1♂ 'ex larva'23.VIII.2006. ***Trioza urticae***, from *Urtica dioica*, Bački breg, 7.VI.2005, reared 1♂; Ilinci, 14.V.2005, reared 1♂, 1♀ 'ex larva'27.V.2005; Luka, 25.V.2007, reared 1♂.

O. niger is widespread in Western Palaearctic, very rare in the Mediterranean region, also reported from China. It is a very polyphagous species, preying on aphids, psyllids, whiteflies, thrips, larvae of noctuids, mites (Péricart 1972, Herard 1986, Protić 1993).

In south France, Herard (1986) determined *Orius niger* on pears as a predator of *Cacopsylla pyri*, but also collected it in a large number from *Trioza urticae* from nettle, which was surrounding the pear orchards. In Croatia, *O. niger* was determined along with *O. minutus* on *Panonychus ulmi* in an apple orchard (Arčanin and Balarin 1972).

In Serbia, Grbić et al. (1989), investigating pear psyllid predators, reported *Orius* spp., so we are not able to compare our results with theirs. In the same paper, authors mentioned the presence of other *Orius* species frequently during summer and autumn which is in accordance with our investigations.

Miridae

8) *Atractotomus mali* Meyer-Dür, 1843

Trophic status. Phytozoophagous.

Distribution. Palaearctic.

Preys. ***Cacopsylla affinis***, from *Crataegus monogyna*, Koruška, 1.V.2008, reared 1♀ 'ex larva'8.V.2008. ***Cacopsylla melanoneura***, from *Crataegus monogyna*, Beograd–Hotel Jugoslavija, 22.IV.2008, reared 2♂♂, 1♀ 'ex larva'30.IV.2008; 18.V.2008, reared 1♀ 'ex larva'23.V.2008; Dobra, 10.V.2008, reared 1♂, 1♀ 'ex larva'21.V.2008; Draževac, 20.IV.2008, reared 1♂, 1♀ 2.V.2008; Koruška, 1.V.2008, reared 1♀ 'ex larva'8.V.2008. ***Cacopsylla melanoneura***, from *Malus domestica*, Ilinci, 24.V.2008, reared 1♀ 'ex larva'30.V.2008; Oparić, 4.V.2008, reared 2♂ 'ex larva'19.V.2008; Ilinci, 2.V.2010, reared 1♀. ***Cacopsylla peregrina***, from *Crataegus monogyna*, Beograd–Hotel Jugoslavija, 22.IV.2008, reared 2♂♂, 1♀ 'ex larva'30.IV.2008; Dobra, 10.V.2008, reared 1♂, 1♀ 'ex larva'21.V.2008; Koruška, 1.V.2008, reared 1♀ 'ex larva'8.V.2008. ***Cacopsylla picta***, from *Malus domestica*, Ilinci, 24.V.2008, 1♀ 'ex larva'30.V.2008.

A. mali has been reported so far as a predator of mites, aphids, thrips, psyllids, butterfly larvae and pupae (Wheeler 2000b). It was registered as a predator of apple psyllid *Cacopsylla mali* in Norway (Jonsson 1983) and of pear psyllid *C. pyri* in Greece (Santas 1987). In Germany, Novak and Achtziger (1995) registered it as a predator of hawthorn psyllids *Cacopsylla* spp.

First record of *A. mali* as a predator of *C. picta*. The above mentioned data are the first ones for *A. mali* as a psyllid predator in Serbia.

9) *Campylomma verbasci* (Meyer-Dür, 1843)

Trophic status. Zoophytophagous.

Distribution. Holarctic.

Preys. ***Cacopsylla bidens***, from *Pyrus communis*, Ilinci, 24.V.2008, reared 1♂ 'ex larva'29.V.2008; Bavanište, 25.V.2006, reared 1♂, 1♀ 'ex larva'30.V.2006. ***Cacopsylla pyri***, ***Cacopsylla pyricola*** and ***Cacopsylla pyrisuga***, from *Pyrus communis*,

Bavanište, 25.V.2006, 1♂, 1♀ 'ex larva'30.V. 2006. ***Cacopsylla melanoneura***, from *Malus domestica*, Ilinci, 2.V.2010, reared 2♂♂.

C. verbasci is a zoophytophagous species preying on apple aphids, pear psyllids, codling moth, thrips and mites (Wheeler 2000b). Its most common prey among insects are *Aphis pomi* and *Cacopsylla mali*, and among mites *Panonychus ulmi* and *Tetranychus urticae* (Hagen et al. 1999, Wheeler 2000b, Bradley 2007).

However, if there is a lack of prey, it can feed on apple fruits, rarely pear, causing the harm to their aesthetic value. Therefore, *C. verbasci* is a significant fruit pest in Canada (Hagen et al. 1999, Wheeler 2000a, Bradley 2007). Erler (2004) reported the presence of *C. verbasci* as a predator of *C. pyri* in treated and untreated pear orchards in Turkey, and Harizanova et al. (2012) mentioned it on *Acizzia jamatonica* in Bulgaria.

Already known in Serbia (Protić 1993) but in our investigations registered for the first time as a predator of psyllids in this country.

10) *Deraeocoris* (*Deraeocoris*) *flavilinea* (A. Costa, 1862)

Trophic status. Zoophytophagous.

Distribution. Western and Central Europe.

Preys. ***Cacopsylla bidens***, from *Pyrus communis*, Beograd–Karaburma, 4.V.2006, reared 1♀ 'ex larva'18.V.2006. ***Homotoma ficus***, from *Ficus carica*, Beograd–Banjica, 21.V.2009, collected 1♂, 2♀♀. ***Trioza rhamni***, from *Rhamnus cathartica*, Beograd–Hotel Jugoslavija, 26.V.2005, reared 1♂ 'ex larva'29.V.2005. ***Psyllopsis discrepans*** and ***Psyllopsis machinosa***, from *Fraxinus angustifolia*, Beograd–Autokomanda, 21.V.2009, 1♂, 1♀.

D. flavilinea is reported so far as a predator of psyllids (Jerinić-Prodanović and Protić 2011, Simov et al. 2012). Until 1980's, it was known only from Sicily, from where it has spread to Central Europe where it is now considered as an invasive species (Rabitsch 2008). As a predator of psyllids, it has been known in Serbia since 2011 (Jerinić-Prodanović and Protić 2011).

11) *Deraeocoris* (*Deraeocoris*) *ruber* (Linnaeus, 1758)

Trophic status. Zoophytophagous.

Distribution. Holarctic.

Prey. ***Cacopsylla pyri***, from *Pyrus communis*, Radmilovac, 10.VII.2006, reared 1♀.

A very polyphagous zoophytophagous species. A Holarctic species occurring in large quantities in the south of Europe.

Already mentioned as a predator of *C. pyri* (Herard 1986). It also preys on younger caterpillar instars of some butterflies, mites and various other small insects in apple orchards, on *Rubus* spp. and *Urtica* spp. as well as on aphids on *Corylus* spp. (Herard 1986).

Reported as a predator of *A. jamatonica* (Harizanova et al. 2012) in Bulgaria and *C. pyri* in Serbia (Jerinić-Prodanović et al. 2010).

12) *Deraeocoris* (*Knightocapsus*) *lutescens* (Schilling, 1836)

Trophic status. Zoophagous.

Distribution. Euro-Mediterranean.

Preys. ***Cacopsylla pyri***, from *Pyrus communis*, Izvor, 14.IV.2009, 1♂. ***Cacopsylla rhamnicola***, from *Rhamnus cathartica*, Obedska bara, 4.VI.2005, reared 1♂ 'ex larva'18.VI.2005. ***Camarotoscena speciosa***, from *Populus nigra*, Zemun–Nova Galenika, 18.X.2010, collected 1♀. ***Psyllopsis fraxinicola***, from *Fraxinus angustifolia*, Zemun–Nova Galenika, 1.IX.2006, collected 1♀. ***Trioza chenopodii***, from *Atriplex oblongifolia*, Galovica, 18.VII.2003, reared 1♂.

D. lutescens is a Mediterranean species, distributed also in small numbers in Central Europe. Known mainly as an egg predator of pear psyllid *C. pyri* and hawthorn psyllid *C. crataegi* (Herard 1986). It is also reported as a predator of aphids and mite *Panonychus ulmi* in apple orchards in Croatia (Arčanin and Balarin 1972) and in pear orchards as a predator of *C. pyri* in France and Turkey (Herard 1986, Erler 2004).

D. lutescens has been already registered in Serbia (Protić 1993) but here is reported for the first time as a predator of psyllids in this country.

13) *Heterocordylus* (*Heterodactylus*) *genistae* (Scopoli, 1763)

Trophic status. Phytozoophagous.

Distribution. Europe.

Prey. ***Cacopsylla melanoneura***, from *Malus domestica*, Beloljin, 4.V.2008, collected 1♂; Ilinci, 20.V.2006, reared 1♂ 'ex larva'25.V.2006; Uzovnica, 29.IV.2007, collected 1 specimen.

H. genistae is mentioned in the literature as a beneficial insect being a predator of psyllids both in larval and adult stage. It is registered as a predator of various other insects (Protić 1993, 1998).

In the present paper, we report *H. genistae* for the first time as a predator of psyllids in Serbia.

14) *Hypseloecus visci* (Puton, 1888)

Trophic status. Zoophagous.

Distribution. Europe.

Prey. ***Cacopsylla visci***, from *Viscum album*, Beograd–Bulevar Aleksandra Karađorđevića, 25.III.2007, reared 4♀♀ 'ex larva'16.IV.2007.

An exclusively zoophagous species.

Already known from Serbia as a psyllid predator (Jerinić-Prodanović and Protić 2011).

15) *Malacocoris chlorizans* Panzer, 1794

Trophic status. Zoophagous.

Distribution. Eurasia.

Prey. ***Homotoma ficus***, from *Ficus carica*, Beograd–Hotel Jugoslavija, 16.V.2007, collected 1♂, 1♀; Beograd–Voždovac, 26.V.2007, collected 5♂♂, 1♀; Zemunski kej, 15.V.2008, collected 1 larva.

A general predator on aphids, psyllids, eggs and larvae of leaf miner moths (Wheeler 2000b, Wyniger and Burckhardt 2003). In Croatia, it is registered as a predator of *Panonychus ulmi* in apple orchards by Arčanin and Balarin (1972).

Malacocoris chlorizans has been already registered in Serbia (Protić 1998) but in the present paper is reported for the first time as a predator of psyllids in this country.

16) *Miris striatus* (Linnaeus, 1758)

Trophic status. Zoophagous.

Distribution. Europe, Central Asia.

Preys. ***Cacopsylla melanoneura*** and ***Cacopsylla peregrina***, from *Crataegus monogyna*, Dobra, 10.V.2008, reared 1♀ 'ex larva'21.V.2008.

Already reported from Serbia (Protić 1993, 1998). The above mentioned record is the first one of *M. striatus* as a predator of psyllids.

17) *Orthotylus* (*Orthotylus*) *marginalis* Reuter, 1884

Trophic status. Zoophytophagous.

Distribution. Eurosiberian.

Prey. ***Cacopsylla rhamnicola***, from *Rhamnus cathartica*, Beograd–Hotel Jugoslavija, 15.V.2008, reared 1♀ 'ex larva'19.V.2008.

O. marginalis is registered as a predator of aphids and psyllids (Wheeler 2000b). In Finland and Russia, it was mentioned as a predator of *C. mali* (Jonsson 1983).

Registered in Serbia (Protić 2011) but here reported for the first time as a psyllid predator.

18) *Psallus* (*Hylopsallus*) *assimilis* Stichel, 1956

Trophic status. Phytozoophagous.

Distribution. Europe.

Preys. ***Psyllopsis discrepans***, from *Fraxinus* sp., Ilinci, 21.V.2005, reared 2♂♂, 2♀♀; Umčari, 25.V.2007, reared 1♀. ***Psyllopsis fraxinicola*** and ***Psyllopsis discrepans***, from *Fraxinus* sp., Beograd–Autokomanda, 10.V.2007, reared 5♂♂, 8♀♀ 'ex larva'16.V.2007.

Figure 3. Larva of *Psallus flavellus* feeding on *Psyllopsis fraxinicola.*

Already known as a predator of various insect species, inlcuding psyllids.

Previously registered in Serbia (Protić 1998) but in the present paper reported for the first time as a psyllid predator in this country.

19) *Psallus* (*Psallus*) *flavellus* Stichel, 1933
Fig. 3

Trophic status. Phytozoophagous.

Distribution. Europe.

Preys. *Psyllopsis* spp., from *Fraxinus* sp., Beograd–Autokomanda, 8.V.2010, reared 3♂♂, 1♀. ***Psyllopsis discrepans***, from *Fraxinus* sp., Beograd–Autokomanda, 13.V.2010, reared 2♂♂, 1♀.

Previously registered in Serbia (Protić 2011). Reported here for the first time as a psyllid predator.

20) *Psallus* (*Phylidea*) *quercus* Kirschbaum, 1856

Trophic status. Phytozoophagous.

Distribution. Europe, Asia.

Preys. ***Psyllopsis discrepans***, from *Fraxinus ornus*, Ilinci, 24.V. 2008, collected 1♀; 17.V. 2009, 1♂, 2♀♀. ***Psyllopsis discrepans*** and ***Ps. machinosa***, from *Fraxinus* sp., Beograd–Autokomanda, 6.V.2009, reared 4♀♀ 'ex larva'10.V.2009; 21.V.2009, reared 1♂, 3♀♀.

So far known as a predator of aphids, psyllids, thrips, spiders and eggs of various insects (Protić 1998).

Registered in Serbia (Protić 2011) but here reported for the first time as a psyllid predator in this country.

21) *Pseudoloxops coccinea* Meyer-Dür, 1843

Trophic status. Zoophagous.

Distribution. Euro-Mediterranean.

Preys. ***Psyllopsis fraxinicola***, from *Fraxinus* sp., Niš, 27.V.2008, collected 1♂. ***Psyllopsis* sp.**, *Fraxinus* sp., Beograd–Autokomanda 8.V.2010, reared 1♂ 'ex larva'21.V.2010.

Registered in Serbia (Protić 1999). Reported for the first time as a predator of psyllids.

Conclusions

From 28 psyllid species and 19 host plants, we reared or collected 21 species of true bugs belonging to the families Anthocoridae and Miridae. According to available literature data, 12 of the recorded species are zoophagous, while the other nine have mixed nutrition.

Miris striatus, *Pseudoloxops coccinea* and *Psallus flavellus* (Miridae) have not been registered as psyllid predators so far. Sixteen species of true bugs are recorded here for the first time as psyllid predators in Serbia (*Anthocoris amplicollis*, *A. nemorum*, *A. confusus*, *Orius majusculus*, *O. niger*, *Atractotomus mali*, *Campylomma verbasci*, *Deraeocoris lutescens*, *Heterocordylus genistae*, *Malacocoris chlorizans*, *Orthotylus marginalis*, *Psallus assimilis*, *Ps. quercus*, *Ps. flavellus*, *Miris striatus* and *Pseudoloxops coccinea*).

From the family Anthocoridae, we identified seven species: *Anthocoris amplicollis*, *A. confusus*, *A. nemoralis*, *A. nemorum*, *Orius majusculus*, *O. minutus* and *O. niger*. The most polyphagous among them was *O. minutus*, found on 13 species of psyllids: *Baeopelma foersteri*, *Cacopsylla melanoneura*, *C. picta*, *C. pyri*, *C. rhamnicola*, *Camarotoscena speciosa*, *Homotoma ficus*, *Psyllopsis discrepans*, *Ps. fraxinicola*, *Ps. machinosa*, *Ps. repens*, *Trioza mesembrina* and *T. rhamni*.

From the family Miridae, we reared or collected 14 species: *Atractotomus mali*, *Campylomma verbasci*, *Deraeocoris flavilinea*, *D. ruber*, *D. lutescens*, *Heterocordylus genistae*, *Hypseloecus visci*, *Malacocoris chlorizans*, *Miris striatus*, *Orthotylus marginalis*, *Psallus assimilis*, *P. flavellus*, *P. quercus* and *Pseudoloxops coccinea*. Among them, the most polyphagous were *C. verbasci*, *D. flavillinea* and *D. lutescens*, each registered on five psyllid species.

Most of predatory true bugs are registered on deciduous perennial plants. We found the highest number of predatory true bugs on psyllids which overwinter on host plant and have more than one generation per year, e.g. *Cacopsylla pyri*, *Psyllopsis fraxinicola* and *Ps. discrepans*. On each of them, seven predatory true bugs were registered. Species from the genus *Psallus* were registered as predators only of psyllid genus *Psyllopsis.*

Further investigations are necessary for the preservation of known beneficial predatory true bugs and finding of new ones, potentially usable for biological control on economically significant psyllid species.

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